



Our Reference: VTE-141-B

PATENT

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## **SUBSTITUTE SPECIFICATION**

### **APPARATUS AND METHOD FOR CHARGING AND DISCHARGING A CAPACITOR TO A PREDETERMINED SETPOINT**

#### **CROSS-REFERENCE TO RELATED APPLICATIONS**

[0001] This application is a continuation of U.S. Provisional Application No. 60/408,468 filed on September 5, 2002 which is incorporated by reference herein. This application is related to U.S. Patent Application No. 10/621,797 filed on July 17, 2003 for an Apparatus and Method for Charging and Discharging a Capacitor.

#### **FIELD OF THE INVENTION**

[0002] The present invention relates to electronic methods and circuits for controlling proportional general purpose, smart material-based actuators.

#### **BACKGROUND OF THE INVENTION**

[0003] Actuator technologies are being developed for a wide range of applications. One example includes a mechanically-leveraged smart material actuator that changes shape in response to electrical stimulus. This change in shape is proportional to the input voltage. Since this shape change can be effectuated predominantly along a single axis, such actuators can be used to perform work on associated mechanical systems including a lever in combination with some main support structure. Changes in axial displacement are magnified by the lever to create an actuator with a useful amount of force and displacement. Such force and displacement is useful for general-purpose industrial valves, clamps, beverage dispensers, compressors or pumps, brakes, door locks, electric relays, circuit breakers, and other applications actuated by means including solenoids, motors or motors combined with various transmission means. Smart materials, however, and piezoelectric materials specifically, can require hundreds of volts to actuate and cause displacement. This type of voltage may not be readily available and may have to be derived from a lower voltage as one would find with a battery.

[0004] Another characteristic of piezoelectric materials is that the materials are capacitive in nature. Moreover, a single actuator is often controlled using three separate signals: a control signal, a main supply and a ground.